

A cross-cultural comparative study into teachers' questioning patterns in lower secondary mathematics lessons in the UK and China

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Teacher questioning has been extensively studied in countries such as the UK since 1980s, however, such study within the specific context of mathematics classrooms has not received much attention. Moreover, there does not exist a direct comparative study between the UK and China with a focus on teachers' questioning in secondary mathematics classrooms. Therefore, this article aims to fill the gap in the literature. This paper looks for similarities and differences in the sequences and patterns of teachers' questioning practices in secondary mathematics classrooms in the UK and China. By making a comparison between the two countries, it is possible to examine the perceived cultural differences and similarities underpinning the use of teachers' questioning.

Keywords: Teacher questioning; Secondary mathematics classrooms; the UK; China

Introduction

The UK government launched a project called 'The Mathematics Teacher Exchange' in 2014, which involved secondary mathematics teacher exchange between schools in England and Shanghai (Boylan et al., 2017). Its intention is to improve students' achievement through copying the Chinese education model. This programme is believed to be successful (ibid) and has been extended to 2020. However, despite the fact that Chinese students have repeatedly outperformed their UK counterparts in school mathematics in various international comparative assessments, there is little comparative research into teacher questioning between the UK and China. Alexander (2009) further suggests a deliberate ignorance of comparative studies of pedagogy in the UK. To address this gap, this exploratory study aims to direct comparative studies of pedagogy in the UK and China, with a focus on teachers' questioning in secondary mathematics classrooms in the hope of providing some explanations from a social-cultural perspective.

There has been a long history of research investigating teacher questioning in the UK context. Extensive research into teacher questioning has witnessed a radical shift in focus from exploring the relationships between teacher questioning and student achievement based on the process-product paradigm in studies conducted before the 1980s (e.g. Mehan, 1979), towards examining questioning from social constructivist perspectives (Chin, 2007). This has followed the educational reform from a traditional transmissive teacher-centred teaching to an inquiry-based teaching that emphasises the social and linguistic nature of knowledge construction in UK classrooms. However, very few studies of teacher questioning have been carried out in

places like China (Ma & Zhao, 2015), where cultural values are different from the UK (Leung, 2001) and where teachers may be constrained by having to deal with larger classes (Chin, 2007) or high-stake examinations (Wong et al., 2012). Traditionally, Confucianism was first and foremost a distinctly Chinese teaching, but it then spread into many East Asian countries such as Japan, Korea, and as well as territories with predominantly Chinese populations such as Hong Kong and Singapore. Confucianism defines much of these East Asian countries' identity, especially in relation to philosophical thoughts and practice (ibid). Wu (1993) studies teachers' questioning patterns in Hong Kong and discovers that students generally have a habit of waiting to be called up before answering teachers' questions. Such student passiveness and reluctance may be explained from a cultural perspective. Chin (2007) carries out several investigations of teacher questioning in science classrooms in Singapore and goes on to suggest that, given the predominant Confucian views of teaching and learning, teachers typically are perceived as expert role models for students, which makes them relatively active in lessons compared to students. Such activeness of a teacher in a lesson can manifest in the form of teacher monologue. Lending support to such findings, Ma & Zhao (2015) have observed 13 primary mathematics lessons in China, and found question-answer exchanges to be the most dominant dialogic form between teachers and students, in which almost all mathematical questions are raised by the teachers.

Teacher questioning is a frequent component of classroom talk. The use of questioning in the West can be traced back to Plato and Socrates, and contemporaneously teachers use questions to stimulate students' thinking (Chin, 2007). Research examining teacher questioning has shown the importance of the kinds of questions teachers ask. Open-ended questions that are not limited within a set of answers can encourage more meaningful responses from students and further stimulate students' logical thinking; whereas closed questions which often refer to those with predetermined answers, tend to limit students' responses into a few simple words and produce merely recall of facts and concepts (Chin, 2007). Thinking about the questions teachers ask is vital, but equally important is thinking about the questioning patterns or sequences that they employ. It is therefore necessary to understand more deeply what happens in classroom exchanges after an initial question is posed, or in other words, what questioning patterns or sequences can occur. Franke et al. (2009) examine teachers' questioning sequences following students' explanations and find that students tend to produce fully complete and correct explanations of their mathematics when asked by teachers' sequential probing questions. Therefore, the focus of this paper is to explore teachers' questioning sequences and patterns employed by two groups of teachers in the UK and China in order to investigate the following research questions:

What are the similarities and differences in UK and Chinese teachers' questioning sequences and patterns in practice?

Methods

A combination of both classroom observation and individual interview were employed, with a group of 11 mathematics teachers of Key Stage 3 pupils (aged 11-14 years) in the UK and a group of 12 mathematics teachers of Year 7 and Year 8 students (aged 11-14 years) in China. Four lower-secondary schools (two from Beijing and Hangzhou, two from Coventry and

Birmingham) were selected, all of which were national-run, state schools. The teachers were teaching various different topics from multiplying decimals to equations with algebraic fractions, and with a wide range of years of teaching experience from newly qualified to very experienced (e.g. some teachers had been teaching for nearly 40 years). The class size ranged from 8-55 students (50 students on average in China, 30 in the UK). Classroom observation was undertaken to answer the research question, focusing on identifying questioning strategies that the teachers might adopt in practice. These were carried out in naturalistic settings in the hope that they could provide rich descriptions of classroom settings to examine naturally occurring teacher questions and to understand the underlying silent social norms and cultural values behind the teachers' behaviours. The individual follow-up interviews were semi-structured and conducted as a supplement to observation to further understand and justify certain patterns of teachers' questions from their own perspectives, which may differ from the researchers' interpretations. Through this, it was hoped that some interesting themes would be uncovered which may not otherwise have been accessible to the researcher. All data were audio-recorded and transcribed and analysed in original languages. Thematic analysis was adopted in this study as it is the most widely used method for identifying themes and patterns of meaning with a clear set of procedures in qualitative research (Braun & Clarke, 2006).

To consider a teacher's question, the research focused on a teacher's utterance that had the grammatical and intonation form of a question, whether it was for the purpose of eliciting information about students' knowledge or thinking or was social act for keeping students' attention. Questions in whole class settings were selected from each observation to analyse. The research attempted to use a discourse analysis approach to analyse the teachers' questioning. The main unit of analysis here was of content units (Hsu, 2001). "A content unit is a piece of discourse that consists of a main question and all the verbal moves made by classroom participants that are directly related to that question in content" (ibid, p. 62). A content unit may not only include a question-answer exchange but might go beyond into the sequences of connected talk associated with a main question. The following extract offers a good example of a content unit:

Excerpt 1 (example from a Chinese lesson)

- Teacher: It is what of the previous call? What exactly?
- Student: The cost of a call.
- Teacher: What? Is it the cost of a previous call?
- Students: Length of a call.
- Teacher: It is it call cost or length of a call?
- Students: Length of a call.
- Teacher: S3, is it the call cost or length of a call?
- Student: Length of a call.

In the process of analysing interview data, both an inductive and deductive approach were used, which included some of the themes taken from the classroom observation. During the analysis,

new issues emerged from the data, therefore, the researcher worked to refine the codes and sub-codes back and forth in a process of inductive and deductive coding.

Results

Individualised vs. collective questioning

One distinct difference lay in the number of students involved in teachers' questioning, which illustrated two opposite questioning patterns. The questioning patterns used by Chinese teachers often took the form of collective questioning, whereas British teachers' questioning patterns were more likely to involve individualised questioning. Specifically, the Chinese teachers frequently posed their questions to the entire class and often involved verbal interaction more than one student. The excerpts above (Excerpt 1) and below (Excerpt 2) are respectively typical examples of questioning to the entire class and questioning to individuals that also involves the rest of the class. The following distinct pattern was only found in the Chinese classrooms. Every single teacher observed adopted this questioning strategy, and used it multiple times in their lessons. A teacher asked students to solve a practical mathematical issue in choosing from three sampling strategies in the textbook.

Excerpt 2

In order to know the eye health of all students from secondary schools across the nation, someone presented the following three sampling methods:

1. To get eye tests for all secondary school students
2. To get eye tests for students from one secondary school
3. On the country level, firstly, divide the country into five areas: east, west, south, north, and middle. Secondly, pick three secondary schools from each area. Thirdly, carry out eye tests for all students from the 15 secondary schools picked.
Which sampling method do you think is the most appropriate?

Teacher: So, someone presented these three sampling methods in order to understand the vision situation of all secondary school students across the country. Li, which one do you think is best?

Li: The third one.

...

Teacher: ... what kinds of issues would rise if we get eye tests for the entire country?

Students: Waste of time.

Teacher: Waste of time. Some students are right. What do we waste?

Students: Waste of energy, waste of people and waste of money...

T&S: Waste of money.

In this excerpt, the teacher asked questions to an individual student Li, but his questions were not individual-centred, because when the teacher continued questioning Li, he set his eyes on the rest of the class, welcoming others to join in this process. Along with the question-answer

exchanges, his follow-up questions with Li were shared and answered among all students in the class, and eventually the teacher and students answer the questions all together.

In contrast, UK teachers asked their questions mostly at an individual level, sticking to one individual student, and keeping eye contact with that individual student until they finished answering the questions or came to the correct understanding. In the process, no other students were allowed to interrupt the interaction between that individual student and the teacher, even when the individual student's solution was incorrect. A classic example can be seen below in Excerpt 3. In one lesson on grouping different cubes and a list of numbers to make a square, rectangle and stick, a teacher had given each group a set of different tasks to complete. As they were looking at square 4 on the board, the following conversation ensued.

Excerpt 3

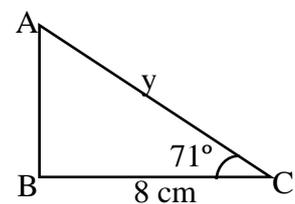
- Teacher: Hannah, how's that 4 made up on the board? How many rows?
- Students: (Inaudible)
- Hannah: (Inaudible)
- Teacher: No, it's Hannah I'm talking to. The 4, Hannah, how many rows has it got?
- Hannah: 2.
- ...
- Teacher: 5, well done.

Moreover, the UK teachers often began by asking questions based on the tasks for all the students, but soon followed this with individual students. Depending on how well they answered the questions, their follow-up questions were frequently modified according to the student's response. In one lesson on Trigonometry's problems, a teacher asked Jane to give solutions to question 2, as shown below.

Excerpt 4

Question 2: $\angle C = 71^\circ$, $BC = 8$ cm, get y .

- Teacher: ...means the hypotenuse on this side. (*Pointing to line BC*) What is 8? (*Using SOHCAHTOA approach*)
- Jane: Opposite.
- Teacher: Why Opposite?
- Jane: Because it's the shortest one.
- Teacher: No... Is the 8 opposite the given angle?
- Jane: No it's the other one.
- Teacher: Okay so what's the 8?
- Jane: Adjacent.
- ...



Teacher: Which one has got the adjacent and the hypotenuse in? Is it sin, cos or tan?

Jane: The middle one.

Teacher: The middle one which is what?

Jane: I don't know.

Teacher: The middle one which is what? Sin, cos or tan?

Jane: Cos.

Teacher: Cos, lovely.

In the excerpt above, the teacher insisted on questioning Jane alone until she came to the final correct answer. Every time when she replied with 'I do not know', the teacher asked more followed up questions that probed or guided her understanding.

The findings from interviews reveal that class size has always been a challenge for Chinese teachers. In order to accomplish lesson objectives in such a short, limited time, it was very hard to ask individualised questions. The UK teachers, in contrast, tried to question every student during the lesson. The lower the ability of the group, the smaller the group size would be: a higher ability group tended to be bigger in class size, but no bigger than 30 students. Classroom management was also seen as a concern by the Chinese teachers. They were not as interested in their students' answers but instead on keeping the lesson going and keeping students all focused. Furthermore, it is believed that most mathematics questions were shared by all students. Instead of questioning one student alone, it would be best to ask the entire class, so that everyone could benefit. Their lesson objectives took priority, the lesson pace was fixed and set to get 2/3 of their students to understand their lessons. In contrast, the UK teachers believed that individualised questioning worked best for their individual students' needs. Each student has their own capacity in learning mathematics, and they should work at the pace of their individual students. When a child fell behind, they would increase questioning specifically to that child.

Discussion

The Chinese questioning pattern has been described by Alexander (2017, p. 28) as "teachers and children address learning tasks together, whether as a group or as a class, rather than in isolation". In the Chinese classrooms observed, teachers and students were facing each other during the whole lesson, and maintained eye contact as much as possible between one adult and a class. These teachers indicated an orientation towards learning together, also called collective orientation (Leung, 2001), and the questioning pattern in their classrooms became a rather collective form of questioning. This collective questioning has been found in other studies investigating Chinese classrooms (Ma & Zhao, 2015). Most of the teachers' questions were answered by all students in unison, echoing the notion of social harmony and the 'obligation of the individual to fit into the social structure' (Leung, 2001, p. 44). In contrast, the UK teachers' questioning pattern demonstrates an orientation towards individualised learning described as individual orientation (ibid), illustrating a relatively individualised questioning pattern. The UK teachers observed firstly started questioning with a task-driven

purpose, but soon followed this conversation with individual students and assessed how well they answered the questions. Their follow-up questions were frequently modified to accommodate the individual student's response, in a much more student-centred approach, which fits the description of Western culture seeing the individual as being of prime importance (Leung, 2001). The difference in the two groups of teachers' questioning patterns is in line with Alexander's (2017) conclusions of collectivism- individualism in Western and Eastern countries. The collectivism-individualism concept refers to "the extent to which the individuals of a society are perceived as autonomous" (Kaiser & Blömeke, 2014, p. 406). The underlying assumptions are about the relations between individuals and the community. Collectivism emphasises "human interdependence, caring for others, and sharing and collaborating, but only in as it serves the larger needs of society, or the state, as a whole" (Alexander, 2003, p. 25). Individualism as its counterpoint, puts "the self above others and personal rights before collective responsibilities". This may create different joint identities for students and teachers in China and the UK, which may then explain their classroom questioning behaviours and their explanations for choosing certain questioning patterns. Most of the time, the Chinese teachers questioned students as a group, rarely as isolated individuals, as they emphasised learning common mathematical knowledge together and sharing uniform learning outcomes, following a single curriculum for all. On the contrary, the UK teachers' student-centred questioning strategy viewed "knowledge as being personal and unique", embracing "individual intellectual differentiation and divergent learning outcomes" (Alexander, 2009, p. 936).

Another issue pertinent difference is class size. Consistent findings concerning class size effects on classroom processes show that small class size is strongly related to the individualisation of teaching, whilst large class size is associated with classroom management and classroom control (Blatchford et al., 2011). Specifically, class size seems to alter the proportion of time spent questioning the whole class, or with individuals. With a large class size of over 50 students, the collective questioning pattern may be adopted in the interest of maximising participation by as many students as possible, encouraging them all as a whole to contribute to the answers. In the smaller class sizes of the UK classrooms, the teachers may be able to offer more personalised questioning to their students who are more often the focus of the teachers' attention (Blatchford et al., 2011). It further reveals that the UK teachers and individual students were often engaged in a sequence of several question-answer exchanges. This may suggest that small class size can sustain teacher-student interactions, whereas large class size tends to cut teacher-student interaction short. The Chinese teachers favoured content-based questioning, the remaining third of their students often comprising the least able students may be potentially left out. In contrast, in the UK, students' abilities are strongly linked to the size of a class. This has given teachers the possibility to challenge and extend all students at their own levels of understanding in mathematics.

To conclude, this study suggests that teacher questioning is a cultural-based pedagogy. Thus, it is hoped that policy makers such as the Department for Education in the UK or the Ministry of Education in China can be openly looking at and learning from other education systems, and incorporating parts in a culturally appropriate way.

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